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REPORT

Physical &
Applied Sci.
Senate

OF



THE SUPERINTENDENT

OF THE

U. S. NAVAL OBSERVATORY

FOR THE

YEAR ENDING JUNE 30, 1894.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

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REPORT OF THE SUPERINTENDENT NAVAL OBSERVATORY.

U. S. NAVAL OBSERVATORY,
GEORGETOWN HEIGHTS,
Washington, D. C., September 10, 1894.

SIR: I have the honor to submit herewith the annual report of the operations of the U. S. Naval Observatory during the year ending June 30, 1894, together with a set of estimates for the support of this establishment for the fiscal year ending June 30, 1896. (Appendix A.)

During the past year regulations for the organization and government of the Naval Observatory have been established by the Navy Department.

Lieut. A. G. Winterhalter, U. S. Navy, was detailed by the Navy Department to establish and conduct the Naval Observatory exhibit at the World's Columbian Exposition at Chicago, Ill.

26-inch equatorial telescope.—Prof. S. J. Brown, U. S. Navy, in charge Asst. Astronomer H. M. Paul, assistant.

The construction of large, complicated, and delicate equatorials is in many respects a new industry in the United States. To put this telescope in working order, and make the changes and additions inherent to the mounting and its accessories, required much care and

thought, together with mechanical skill of a high order, and necessarily consumed a considerable amount of time.

Adjustments and changes have been made in the following parts, namely:

The filar-micrometer and the large tube.

The dial indicator on the pier and its connection to the elevating floor.

The control valves for raising and lowering the elevating platform.

The rope pulleys for rapid handling and setting of the telescope.

The adjustment of the polar axis to the plane of the meridian.

The designing of electric lamps, the entire wiring of the instrument for electric illumination and for electric control of the driving clock, and the arrangement of an observing-key for the chronograph at the eye end of the telescope.

Other minor changes have also been completed.

Some of these alterations were made by the makers; but the electric lighting, driving-clock-control and chronograph-key systems were planned and the work performed at the Observatory.

Some minute irregularities exist in the action of the driving-clock connections upon the telescope, and much time has been expended in finding their origin.

The spectroscope has been so modified that it is now readily attached and detached from the telescope.

A number of observations of Saturn's satellites have been made, and preliminary work is commenced with the spectroscope.

Prof. Asaph Hall, U. S. Navy (retired), the distinguished astronomer who discovered the satellites of Mars, has kindly consented to make further observations of them during the opposition of that planet in November next.

12-inch equatorial telescope.—Prof. Edgar Frisby, U. S. Navy, in charge.

The 12-inch object glass of this instrument is not yet made, as the appropriation for that purpose (\$2,000) was not available at the close of the fiscal year. A 9.6-inch objective has, however, been temporarily fitted and used during the past year. The adjustment of this new instrument, involving minor mechanical changes, principally in the form of the micrometer, and generally getting the telescope into good working condition, including the necessary observations for finding the values of the wire intervals in right ascension and declination, and the value of the micrometer screw in seconds of arc, occupied considerable time before the instrument was regarded as satisfactory. Although a number of asteroids, and comet C, were observed prior to April, 1894, regular work with the instrument was not commenced until that date. For two nights each week this telescope has been regularly devoted to entertaining visitors; 3,200 passes were issued, and in addition, a number of distinguished persons were received at other times. On other clear nights during the months of April, May, and June comet Gale, the asteroid Germania, and an emersion of α Virginis from the moon were observed.

9-inch transit circle.—Asst. Astronomer A. N. Skinner in charge. Computers F. B. Littell and Theo I. King, assistants.

The contract for this instrument will not be completed until a proper object glass is furnished by the contractor. The present objective gives sharp definition over so small a field that observations only over the central wires are satisfactory. Considerable time was occupied in ascertaining the defects of this objective; nevertheless, pending the arrival of its substitute, work was commenced on the German Astronomical Society's zone,— $13^{\circ} 50'$ to $18^{\circ} 10'$, in January, 1894. From that date to June 30, 1894, 55 zones have been observed, comprising

4,444 zone stars and 496 zero stars. The zero stars have been reduced through zone 40. All the chronographic records of transits have been read off and the reduction of the zone stars to the mean thread commenced.

Prime vertical instrument.—Asst. Astronomer George A. Hill in charge. Observations for declination were made upon α Lyrae on all clear nights, and on μ Andromedæ, ρ Persei, θ Aurigæ, α Canum Venaticorum, and γ Boötis at the time of maximum aberration of these stars.

6-inch transit circle.—This new meridian circle was contracted for under specifications on March 20, 1893. The time for its completion is extended till March 1, 1895.

5½ inch meridian transit instrument, chronometer, and time service.—Lieut. L. C. Heilner, U. S. Navy, in charge. Computer Frank E. Dennett, assistant.

Observations have been taken every clear night, and the necessary reductions for clock corrections in connection with the time service and chronometer comparisons have been made.

There are at present in the chronometer room ready for issue 31 standard chronometers, 6 hacks, 3 sidereal break-circuit chronometers, and 1 mean-time break-circuit chronometer.

During the past year 35 standard chronometers, 12 hack chronometers, 7 comparing watches, 6 stop watches, and 9 maximum and minimum thermometers have been issued to naval vessels. Six standard chronometers were forwarded by the U. S. S. *Charleston* to the Mare Island navy-yard, also 6 comparing watches; 1 mean-time break-circuit chronometer was transferred to the Branch Hydrographic Office, Chicago, and 1 chronometer has been issued to the Branch Hydrographic Office, Baltimore, Md.

The Observatory has received 17 standard chronometers, 10 hacks, and 6 comparing watches from naval vessels; 1 chronometer and 7 hacks from Mare Island navy-yard; 2 chronometers from the Nautical Almanac Office; 1 chronometer (Losada, No. 3727) from the Spanish caravals at the World's Columbian Exposition, and 12 chronometers purchased after undergoing the rigid test required by specifications.

Twenty-five standards and 10 hacks have been repaired and returned to the Observatory. Twenty-seven standards and 4 hack chronometers are now undergoing repairs.

The new temperature room for the trial and testing of chronometers has proved satisfactory. The exacting and responsible routine of this department involves continuous work, both night and day, from the officer in charge and his assistant.

The time service continues to give satisfaction to the public. A time ball has been established at Chicago, and during the year requests have been received for a similar plant at other places. The noon signal has been transmitted daily with the exception of Sundays, and the apparatus for transmission of time has worked satisfactorily and without interruption. A new sidereal clock was purchased, and a mean-time clock recently constructed is now under trial.

Magnetic Observatory.—Lieut. C. C. Marsh, U. S. Navy, in charge. Occasional assistant, J. N. James, electrician.

The work in the magnetic department for the past year has been as follows: The summer and fall of 1893 were occupied in finishing the building and vault; in constructing the several piers necessary for the instruments now on hand and those that it was seen would soon be

required; in concreting the floor of the basement and tunnel, and in laying ventilating and heating pipes, etc.

The regular observations began in January, 1894, since which time the records have been carried on continuously, losing unavoidably only a few hours.

As this is a new station it was thought best to make absolute determinations of the magnetic elements more frequently than usual, and accordingly, such determinations have been made twice a day for the declination, and four times a week for the inclination and horizontal force.

Better results are anticipated from the new instruments about to be purchased, but the appropriation for them was not available until after July 1, 1894.

Photography.—Mr. Charles T. Fellows, photographer in charge.

The photographic building and photoheliograph are not yet completed, owing to the want of funds. It is, however, contemplated that systematic observations of sun spots will be commenced shortly. In the programme of this work it is proposed to take sun photographs, daily, when practicable, and to accumulate as much data as possible for the advancement of solar physics. Photographic work with an equatorially mounted star camera will also be commenced at an early date.

LIBRARY.

The library is under the supervision of a committee composed of Prof. William Harkness, Prof. J. R. Eastman, and Assistant Librarian William D. Horigan, Mr. Horigan acting as librarian.

The contents of the library at the beginning and end of the fiscal year 1893-'94, with the accessions during the year, as shown by the accession book, were as follows:

	Volumes.	Pamphlets.	Total.
Contents 1893, June 30.....	14, 100	3, 204	17, 304
Accessions during 1893-'94.....	396	59	455
Contents 1894, June 30	14, 496	3, 263	17, 759

Of the 455 accessions, 263 were received as exchanges and 192 were purchased.

The following publications have been distributed to the regular exchange lists:

The Annual Report of the Superintendent for 1893.
 The Washington Observations for the year 1889.
 Magnetic Observations for 1892.
 Meteorological Observations and Results for 1889.
 1890 Appendix 1.—Gilliss's Zone Catalogue.

MISCELLANEOUS REMARKS.

The preparation of specifications for the new meridian circle (6-inch), for the 9-inch transit circle objective, for sextants, octants, binocular and spy glasses, and the inspection of nautical and astronomical instruments purchased and repaired during the year have required study, thought, and the solving of complex problems. This work, together

with drafting many technical letters, has occupied the valuable services of Prof. William Harkness, U. S. Navy, both in and out of office hours.

The work of preparing the data for the transit circle star catalogue, embodying the results of the observations from 1866 to 1891, or in other words, all observations made with that instrument at the old Naval Observatory, excepting those of the moon and planets, has been carried on by Prof. J. R. Eastman, U. S. Navy, during the past twelve months and is now nearly completed. It is contemplated to assign this astronomer to duty in charge of fundamental observations with the new meridian circle as soon as it is mounted.

The tedious and troublesome work of reducing and preparing the Gilliss zones has been completed by Prof. Edgar Frisby, U. S. Navy, and Prof. S. J. Brown, U. S. Navy, and the catalogue is now in print.

In addition to making daily computations credit is due Computers King, Littell, and Dennett for performing night work as observers, or assistants to the astronomer in charge of the German zone observations.

Attention is invited to House Ex. Doc. No. 46, Fiftieth Congress, second session, and estimates for an appropriation for the purchase of a photographic telescope and pointer and the construction of the necessary buildings for charting the sky, are again submitted.

PERSONNEL.

Prof. Simon Newcomb, U. S. Navy, superintendent of the Nautical Almanac Office, entered the Navy in 1861 and retires in 1897.

Prof. William Harkness, U. S. Navy, entered the Navy in 1863, since which date he has been engaged in astronomical work. He retires in 1899.

Prof. J. R. Eastman, U. S. Navy, has been engaged on astronomical work since 1865, and retires in 1898.

Prof. Edgar Frisby, U. S. Navy, received his appointment in 1878, after ten years of service at the Naval Observatory. He retires from active duty in 1899.

Prof. S. J. Brown, U. S. Navy, a graduate of the Naval Academy, was appointed professor of mathematics in 1883, and has been engaged in astronomical work since that date. He retires in 1916.

The remainder of the twelve professors of mathematics, U. S. Navy, are not regarded as astronomers.

Unless, therefore, the corps of professors of mathematics, U. S. Navy, is reorganized, the Naval Observatory will in the near future have but one astronomer available for duty.

Asst. Astronomer A. N. Skinner (\$2,000) has been at the Naval Observatory twenty-four consecutive years.

Asst. Astronomer H. M. Paul (\$1,800) has been attached to the Naval Observatory, with intermission, sixteen years.

Asst. Astronomer George A. Hill (\$1,800) was employed as computer for three years and in his present position over one year.

Computers Frank E. Dennett, Frank B. Littell, and Theo. I. King were appointed in 1891, Computer Ernest A. Boeger in 1892, and Computer William M. Brown in 1894 (\$1,200 each).

The following table presents the personnel necessary to conduct the work at the U. S. Naval Observatory:

Detail.	Line officers.	Professors of mathematics.	Assistant astronomers.	Computers.
Superintendent's office.....	2	1	.....	*1
26-inch equatorial.....	.....	1	.....	.....
12-inch equatorial.....	.....	1	.....	.....
6-inch transit circle.....	.....	1	.....	1
9-inch transit circle.....	.....	1	3	5
5½-inch transit instrument, chronometer and time service.....	2	.....	.....	1
Prime vertical instrument.....	.....	.....	1	.....
Magnetic instruments.....	2	.....	.....	.....
Nautical instruments and storekeeper.....	1	.....	.....	.....

* Also 1 clerk and 1 copyist-typewriter.

Present Observatory staff.—Capt. F. V. McNair, U. S. Navy, superintendent. Commander Joshua Bishop, U. S. Navy, assistant to superintendent. Lieut. L. C. Heilner, U. S. Navy, 5½-inch transit instrument, chronometer and time service. Lieut. C. C. Marsh, U. S. Navy, magnetic establishment. Prof. of Mathematics William Harkness, U. S. Navy, special duty, transit of Venus; chief astronomical assistant to the superintendent. Prof. of Mathematics J. R. Eastman, U. S. Navy, fundamental work, 6-inch meridian transit circle (under contract). Prof. of Mathematics Edgar Frisby, U. S. Navy, 12-inch equatorial telescope. Prof. of Mathematics S. J. Brown, U. S. Navy, 26-inch equatorial telescope. Asst. Astronomer A. N. Skinner, differential work, 9-inch transit circle. Asst. Astronomer H. M. Paul, assistant, 26-inch equatorial telescope. Asst. Astronomer George A. Hill, prime vertical instrument. Computers Frank B. Littell and Theo I. King, assistants, 9-inch transit circle. Computers Ernest A. Boeger and William M. Brown, computation. Computer Frank E. Dennett, assistant, 5½-inch transit instrument, and chronometer and time service. Clerk Thomas Harrison, correspondence and accounts. Mr. Robert H. Coker, copyist-typewriter.

Whenever there are an insufficient number of line officers on duty at the Naval Observatory competent to care for the chronometer and time service, it is manifestly imperative to assign professors, assistant astronomers, or computers for that work.

Very respectfully,

F. V. MCNAIR,

Captain U. S. Navy, Superintendent of Naval Observatory.

THE CHIEF OF THE BUREAU OF EQUIPMENT,

Navy Department.

